cules, therefore, must be classed by themselves in a distinct state or category.

The same reasoning applies to two or to any number of contiguous molecules, provided their motion is arrested or controlled, so that no collisions occur between them; and even supposing this aggregation of isolated non-colliding molecules to be bodily transferred from one part of space to another, that kind of movement would not thereby cause this molecular collocation to assume the properties of gas; a molecular wind may still be supposed to consist of isolated molecules, in the same way as the discharge from a mitrailleuse consists of isolated bullets.

Matter in the fourth state is the ultimate result of gaseous expansion. By great rarefaction the free path of the molecules is made so long that the hits in a given time may be disregarded in comparison to the misses, in which case the average molecule is allowed to obey its own motions or laws without interference; and if the mean free path is comparable to the dimensions of the containing vessel, the properties which constitute gaseity are reduced to a minimum, and the matter then becomes exalted to an ultra-gaseous state.

But the same condition of things will be produced if by any means we can take a portion of gas, and by some extraneous force infuse order into the apparently disorderly jostling of the molecules in every direction, by coercing them into a methodical rectilinear movement. This I have shown to be the case in the phenomena which cause the movements of the radiometer, and I have rendered such motion visible in my later researches on the negative discharge in vacuum tubes. In the one case the heated lamp-black and in the other the electrically excited negative pole supplies the *force majeure* which entirely or partially changes into a rectilinear motion the irregular vibration in all directions; and according to the extent to which this onward movement has replaced the irregular motions which constitute the essence of the gaseous condition, to that extent do I consider that the molecules have assumed the condition of radiant matter.

Between the third and the fourth states there is no sharp line of demarcation, any more than there is between the solid and liquid states, or the liquid and gaseous states; they each merge insensibly one into the other. In the fourth state properties of matter which exist even in the third state are shown *directly*, whereas in the state of gas they are only shown *indirectly*, by viscosity and so forth.

The ordinary laws of gases are a simplification of the effects arising from the properties of matter in the fourth state; such a simplification is only permissible when the mean length of path is small compared with the dimensions of the vessel. For simplicity's sake we make abstraction of the individual molecules, and feign to our imagination *continuous* matter of which the fundamental properties—such as pressure varying as the density, and so forth—are ascertained by experiment. A gas is nothing more than an assemblage of molecules contemplated from a simplified point of view. When we deal with phenomena in which we are obliged to contemplate the molecules individually, we must not speak of the assemblage as *gas*.

These considerations lead to another and curious speculation. The molecule—intangible, invisible, and hard to be conceived—is the only true *matter*, and that which we call matter is nothing more than the effect upon our senses of the movements of molecules, or, as John Stuart Mill expresses it, "a permanent possibility of sensation." The space covered by the motion of molecules has no more right to be called matter than the air traversed by a rifle bullet can be called lead. From this point of view, then, matter is but a mode of motion; at the absolute zero of temperature the inter-molecular movement would stop, and although *something* retaining the properties of inertia and weight would remain, *matter*, as we know it, would cease to exist.

NOTES

The Council of the Society of Arts have awarded the Albert Medal of the Society of the present year to James Prescott Joule, LL.D., D.C.L., F.R.S., "for having established, after most laborious research, the true relation between heat, electricity, and mechanical work, thus affording to the engineer a sure guide in the application of science and industrial pursuits." The medal was delivered to Dr. Joule by the Prince of Wales on Tuesday, when Sir William Thomson received the medal awarded him by the Society in 1878.

The Paris Academy of Sciences has awarded the Monthyon Prize to M. Camille Flammarion for his new work entitled "Astronomie Populaire." It is a large 4to volume, with magnificent engravings, which was sold in 100 penny parts. The sale in the first year of publication reached 40,000 copies.

It is stated that M. Coggia, Astronomer to the Marseilles Observatory, will be appointed Director of the Algiers Observatory, where no observations at all have been made since its creation in 1864 by Marshal Pelissier.

The University of Oxford has conferred the degree of D.C.L on Prof. Sylvester and Mr. Lister, the eminent surgeon.

On Saturday, May 5, the local committee of the French Association for the Advancement of Science met at Rheims, where the next meeting is to be held in August. An exposition of local industry and archæology will be held. Arrangements have been made for excursions connected with the congress, the more notable of which will be to the Han Grottoes, which are situated in Belgium. Nothing has been arranged yet as to the lectures to be delivered.

The new Principal of the Royal Agricultural College, Cirencester, the Rev. J. B. McLellan, has started a scheme of congresses or conferences which may prove of considerable value to agriculture. On Friday, the 5th inst., a goodly number of old Cirencester students and professors, as well as local agriculturists, met in the College Hall to discuss important agricultural questions. The morning session was occupied with the subject of cattle diseases; the afternoon was devoted to agricultural stations and research. If the papers introducing the subjects were not of a very high order, it may at least be conceded that the discussions which followed brought out some sound information and advice. If such congresses as this at Cirencester help to draw public attention to the need for some new departure in modern and scientific agriculture, and if they stimulate those interested in farming to look to the College as the central authority on a subject which that institution must learn to handle adequately, then we predict for them a substanial success.

The annual conference at the Society of Arts on the laws, administration and inspection with regard to public health was opened on Thursday under the presidency of Mr. Stansfeld, M.P. The committee had drawn up a programme of subjects for discussion, which were grouped under the following headings:—1. Administrative Organisation: 2. Amendment of the Law: 3. Sanitary Inspection and Classification of Dwellings: 4. Further suggestions by Sanitary Authorities. In the discussion on Thursday the chairman, in opening the proceedings, pointed out the desirability of an "inquiry office" being established in connection with the Local Government Board, at which local authorities might obtain information based on experience. One great hope for the future was that the teaching of the laws of health to children was gradually spreading. The conference was resumed on Friday. In reference to the third heading, the following resolution was put to the meeting:—"That it is expedient that the Metropolitan Board of Works within the metropolis, and the County Board within each county, should be empowered by the Legislature to make provision for the inspection and sanitary classification of dwellings, upon application being made by the owners thereof, and to grant certificates of healthworthiness in different categories, for terms of years, according to the perfection of sanitary equipment and fitness for habitation of such dwellings; and to determine the scale of fees to be paid for such inspection during construction and repair, and also upon delivery to the applicant of the certificate of classification awarded to such dwelling. In the long discussion which followed it was clear that the sense of the conference was in favour of some change, but opinions were much divided as to how inspection and certificates should be brought to bear. Among other arguments it was urged that, as Lloyd's Association inspected the construction of ships and granted certificates, it would be only an extension of a recognised system to inspect and give certificates for houses. After a protracted discussion, the resolution was passed with some few alterations. An exhibition of sanitary appliances was open free to the public. The chief novelty was the new filtering medium adopted by the Admiralty and War Office named Carferal, on which Prof. De. Chaumont has recently reported so favourably.

Mr. R. L. Jack, the Government Geologist of Queensland, has been carrying out his survey operations under difficulties unknown to home geologists. While he and his party were pursuing their explorations in the north of York Peninsula they were attacked by a band of natives, Mr. Jack receiving a spear in the neck, which had to be cut out. Fortunately the wound, though troublesome, is not likely to be attended with any serious or permanent results. North of Temple Bay Mr. Jack came upon a hitherto unknown large river, which he has named the "Macmillan."

The *Daily News* gives some account of a recent lecture by Prof. Palmieri on earthquakes. Prof. Palmieri went on to say that earthquakes have no doubt shorter or longer periods of preparation. The earth is never perfectly quiet for some time before and after a great shock, but gradually sinks into repose or increases in agitation. The Professor believes that, by registering the slight preliminary tremblings and noticing their increase or decrease it would be possible to forestall an earthquake about three days in advance, just as tempests are now foretold. If a connected system of seismographic stations were to be organised—the different stations communicating with each other by telegraph—it would be quite possible, in most cases, to issue warnings to the threatened district in time. The seismographic stations should be erected by the different Governments in quiet places where the ground was not liable to be shaken by heavy railway trains.

The illumination of the park of the Industrial Exhibition of Melun with Wild candles has been considered successful, and will be continued every night during the whole of the summer. It is said that the proprietors of the Wild patent will take an injunction against M. Jamin for an infringement of their patent, alleging that his directing frame is not an independent invention.

M. W. de Fonvielle has discovered that the intermittent current of the frame of his electro-magnetic gyroscope can be made continuous if the magnet is replaced by an electro-magnet worked by an interrupter.

The French Government has taken an important step in the education of the people; a course of teaching in agriculture has been ordered to be introduced into every primary school in the country.

Messrs. Macmillan and Co. have published a sixth edition of the late Prof. George Wilson's well-known little book, "The Five Gateways of Knowledge."

Chemists engaged in the analysis of alcoholic liquids will be able shortly to possess an elaborate and complete series of tables of spirit gravities, prepared by Dr. Thos. Stevenson, of Guy's, and to be published in handy book size by Mr. Van Voorst.

Mr. G. Ambrose Pogson, British Vice-Consul at Hamburg, writes to the *Times* from that place, under date June 12, as to "St. Elmo's Fire":—A series of thunderstorms, he states, has lately passed over Hamburg. During the 11th inst. the air was densely charged with electricity; the storm broke about 10.15 p.m., lasting until 11 p.m., during which time, at very short intervals, from my station, about 1,200 yards distance from the copper-roofed tower of the church known as St. Jacobi, about 300 feet high, I saw this phenomenon apparently resting about 30 feet from the summit of the steeple. The colour was a reddish purple, and reminded one somewhat of burning potassium. From repeated comparisons with other objects during the lightning flashes, I judged these fire-balls (two were several times visible) to be from 4 feet to 6 feet in diameter. The longest duration that I timed was 42 seconds. This passing away of such dense masses of electricity by induction was visible some twenty times, but whether performed silently I had no means of ascertaining. From the apparent size of flame and the non-lighting quality of the colour, I estimated it as equal to 10,000 candles. The colour was doubtless the effect of the glare of the copper roof.

During 1881 no less than five exhibitions will be held at Frankfort-on-the-Main, viz., a patent exhibition, a horticultural, a balneological, an industrial, and a tanner's and furrier's exhibition.

A meeting of the members of the Aëronautical Society of Great Britain will be held at the Society of Arts, Adelphi, on Monday, June 21, for the reading and discussion of papers, and generally for the advancement of the Society's interests. The chair will be taken precisely at 8 p.m.

We are requested to make the following announcement with regard to the Sunday Art Exhibitions of the Sunday Society:—On Sunday, June 20, the first exhibition at the Hanover Gallery, including Hans Makart's great picture of the Entry of Charles V. into Antwerp, will be open to the members of the Society, and on the two following Sundays, June 27 and July 4, the public will be admitted by means of free tickets, which will be issued to those who apply by letter, sending a stamped and addressed envelope to the Honorary Secretary, 6, Dudley Place, W. On each Sunday the Gallery will be opened from 3 till 9 p.m. The Grosvenor Gallery will be opened to the members of the Society on Sunday, July 25, and to the public on Sunday, August 1, by tickets to be had on written application as above.

On Saturday the Geologists' Association and the West London Scientific Association make a combined excursion to Croydon and Riddlesdown.

The additions to the Zoological Society's Gardens during the past fortnight include a White-throated Capuchin (*Cebus hypoleucus*) from Central America, presented by Miss Baker; a Toque Monkey (*Macacus pileatus*) from Ceylon, presented by Mr. H. P. Brenan; a Brown Bear (*Ursus arctos*) from Asia, presented by Mr. Chas. Overbeck; a Pig-tailed Monkey (*Macacus nemestrinus*) from Java, presented by Mr. W. C. Lawes; a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. T. H. Adey; a Black-eared Marmoset (*Hapale penicillata*) from South-East Brazil, presented by Mr. G. Mantell; three Slender Loris (*Loris gracilis*) from Ceylon, presented by Lord Lilford, F.Z.S.; a Dingo Dog (*Canis dingo*) from Australia, presented by Lord Ernest Gordon; a White Pelican (*Pelecanus onocrotalus*) from North Africa, presented by Mr. J. Simonds; a Musky Lorikeet (*Trichoglossus concinnus*) from Australia, presented by Mr. A. H. Jamrach; a Horsfield's Tortoise (*Testudo horsfieldi*) from Afghanistan, presented by Capt. Cotton; two Smooth Snakes (*Coronella lævis*), British, presented respectively by Mr. W. Penny and Mr. Thos. J. Mann; two Yellow-headed Troupials (*Xanthocephalus icterocephalus*) from Mexico, presented by Mr. W. A. Conklin; a Jaguar (*Felis onça*) from Bolivia, two Common Boas (*Boa constrictor*) from Savanilla, deposited; a Ring-tailed Lemur (*Lemur catta*) from Madagascar, a Ludio Monkey (*Cercopithecus ludio*), a Mona Monkey (*Cercopithecus mona*), two Rus's Weaver Birds (*Quelea russi*), two Cinereous Waxbills (*Estrelda cærulescens*), two Crimson-eared Waxbills (*Estrelda phœnicotis*) from West Africa, a Black-footed Penguin (*Spheniscus demersus*), a Levaillant's Parrot (*Pœocephalus robustus*), from South Africa, a Brahminy Kite (*Haliastur indus*) from South Asia, a Brown Crane (*Grus canadensis*) from North America, a Double-crested Pigeon (*Lopholœmus antarcticus*) from North Australia, two Swift Parrikeets (*Lathamus discolor*) from Tasmania, two Victoria Crowned Pigeons (*Goura victoriæ*) from the Island of Jobie, four Bengal Weaver Birds (*Ploceus bengalensis*) from India, a Red Lory (*Eos rubra*), an Ornamental Lorikeet (*Trichoglossus ornatus*) from Moluccas, a White-billed Parrakeet (*Tanygnathus albirostris*) from Celebes, a Noble Macaw (*Ara nobilis*) from Brazil, two Yellow-fronted Amazons (*Chrysotis ochrocephala*) from Panama, a White headed Parrot (*Pionus senilis*) from Mexico, two Black-headed Conures (*Conurus nanday*) from Paraguay, two Silky Marmosets (*Midas rosalia*) from South-East Brazil, a Leucoryx Antelope (*Oryx leucoryx*) from North Africa, a Common Otter (*Lutra vulgaris*), British, three Chinchillas (*Chinchilla lanigera*) from Chili, an Upland Goose (*Bernicla magellanica*) from the Falkland Islands, three Ashy-headed Geese (*Bernicla poliocephala*) from South America, purchased; an Anoa (*Anoa depressicornis*) from Celebes, received in exchange; an Axis Deer (*Cervus axis*), a Japanese Deer (*Cervus sika*), a Geoffroy's Dove (*Peristera geoffroii*), a Wonga-wonga Pigeon (*Leucosarcia picata*), a Turquoisine Parrakeet (*Euphema pulchella*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN

FAYE'S COMET.—Dr. Axel-Möller commences his ephemeris of Faye's comet for the present year on July 1, when its distance from the earth will be 2·005, and that from the sun 2·53; the perihelion passage will not take place till January 22, 1881. The intensity of light corresponding to the comet's distances on July 1 is 0·039; in 1844 it was observed with sensibly the same intensity, the value for the last observation with the 15-inch refractor at Pulkowa being 0·035. The comet attains its greatest brightness in the middle of October, when the value corresponds to that at the last observation in 1858, with the 9·6-inch refractor at Berlin on October 16. At discovery by M. Faye in 1843 the theoretical intensity of light was 0·54, which has not been approached at any of the subsequent returns. The following positions are taken from Dr. Axel-Möller's ephemeris, which is calculated for Berlin midnight, or about 11h. G.M.T.:—

	Right Ascension.	Declination.		Right Ascension.	Declination.
	h. m. s.	° ′		h. m. s.	° ′
July 1 ...	23 5 25 ...	+7 53·5	July 17 ...	23 13 17 ...	+ 9 34·5
3 ...	23 6 38 ...	8 7·7	19 ...	23 13 57 ...	9 44·8
5 ...	23 7 47 ...	8 21·4	21 ...	23 14 32 ...	9 54·6
7 ...	23 8 52 ...	8 34·8	23 ...	23 15 2 ...	10 3·6
9 ...	23 9 54 ...	8 47·7	25 ...	23 15 27 ...	10 12·0
11 ...	23 10 51 ...	9 0·1	27 ...	23 15 47 ...	10 19·7
13 ...	23 11 44 ...	9 12·1	29 ...	23 16 2 ...	10 26·6
15 ...	23 12 33 ...	+9 23·6	31 ...	23 16 12 ...	+10 32·8

The comet will arrive at its least distance from the earth (1·09) on October 3. So far as can be foreseen without calculation of the perturbations the comet is not likely to exhibit a degree of brightness approaching that in the year of its discovery by M. Faye, until 1903.

While Faye's comet is followed up by Dr. Axel-Möller in the same admirable manner as for many years past, calculations relating to other comets of short period are in the hands of the following astronomers according to the last Report of the *Astronomisches Gesellschaft*:—Dr. Backlund of the Imperial Observatory, Pulkowa, proceeds with the perturbations of Encke's comet, taking up the work where it was left by the late Dr. v. Asten; Brorsen's comet is undertaken by Prof. R. Schulze of Döbeln; D'Arrest's by M. Leveau of Paris; Winnecke's by Prof. Oppolzer of Vienna; Tempel's comet of 1867 by M. Gautier of Geneva; Tempel's second comet (1871), by M. Schulhof of Paris; and Tuttle's comet, due in the year 1885, by Mr. Ormond Stone of Cincinnati. The exceptional case of Biela's comet is not provided for.

THE GREAT SOUTHERN COMET OF 1880.—Dr. M. W. Meyer, of Geneva, assuming for the period of revolution of this comet the interval between the perihelion passage of the great comet of 1843 and that of the comet in 1880, corresponding to a semi-axis major of 11·0869, has adapted the other elements of the orbit thereto by means of Dr. B. A. Gould's observations at Cordoba on February 6, 12, and 19, covering an interval which, so far as we know at present, is only one day less than the whole extent of accurate observation: the Cordoba observations of February 5 await the meridional observation of the comparison star, which is not found in our catalogues: it may be well determined at one of the observatories of Southern Europe. Dr. Meyer's results are as follows:—

Perihelion passage, 1880, January 27·44242 G.M.T.

	° ′ ″		
Longitude of perihelion ...	...278 22 47	}	Mean equinox,
,, ascending node	...356 16 43	}	1880·0
Inclination of the orbit ...	... 36 52 13		
Log. excentricity (=log. sine ϕ)	9·9997682		or $\phi = 88° 7' 41''·55$
Log. perihelion distance ...	...7·7720095		

Motion retrograde.

The aphelion distance in this orbit is 22·1679 (the earth's mean distance being taken as *unity*), and at aphelion the comet is distant from the orbit of Uranus 13·15. The nearest approach to the orbit of Jupiter, about 3·1, takes place when the true anomaly is about 176° 35′. The comet's orbital velocity at perihelion is 338 miles in a second, and that at aphelion 477 feet in the same interval.

MINIMA OF ALGOL.—The following times of geocentric minima of Algol, observable in this country during the ensuing quarter, are deduced from the elements given by Prof. Schönfeld in his catalogue of 1875. Considerable perturbations of epoch appear to have taken place during the last five years, as we have previously noted in this column, and from the course of the errors of calculation it seems quite possible that the computed times may be nearly a half-hour too late. Systematic observations of this variable are now much to be desired, and it may be hoped that one or more of the many zealous amateur-astronomers here will devote attention to it. The perturbations to which we have alluded were particularly evident in 1876, and the error of the calculated times attained a maximum in the following year, a mean of seven observations by Prof. Julius Schmidt at Athens showing that the computed epoch was too late by forty-eight minutes. The following epochs are directly comparable with observation:—

	h. m.			h. m.	
July 16 ...	12 39·0	G.M.T.	Aug. 25 ...	12 47·9	G.M.T.
19 ...	9 27·5	,,	28 ...	9 36·4	,,
Aug. 2 ...	14 19·6	,,	Sept. 14 ...	14 27·7	,,
5 ...	11 8·2	,,	17 ...	11 16·2	,,
22 ...	15 59·4	,,	20 ...	8 4·8	,,

PHYSICAL NOTES

ACCORDING to our contemporary *l'Électricité*, M. Exner of Vienna has discovered that a bismuth-antimony pair immersed in a gas incapable of acting chemically on either of these metals yields no current when one junction is heated. Also that if two bars of copper are soldered together to form a "pair" no current is produced when either junction is heated in air (as would be expected in a circuit of one metal), not even when both strips are exposed to the action of chlorine; but that if one strip only is exposed to chlorine gas and then one junction be warmed a thermo-electric current is set up. According to Exner therefore, all so-called thermo-electric currents are due to chemical action. It would be easy for some of our ardent young physicists to put to the test this very remarkable announcement, and see whether